IN THE MATTER OF
Patent Application of
HONDA MOTOR CO., LTD.

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Signed this 25th day of December, 2009

By N. Suda
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[Prepayment Register Number]	001834
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[List of the Attached Documents]

[Document Name]	Specification	1
[Document Name]	Drawings	1
[Document Name]	Abstract	1
[General Power of Attorney Number]		9711295
[General Power of Attorney Number]		0206309
[Proof]	Necessary	

[DOCUMENT NAME] Specification

[TITLE OF THE INVENTION]

FUEL CELL

[CLAIMS]

[Claim 1]

A fuel cell formed by stacking an electrolyte electrode assembly and separators alternately, said electrolyte electrode assembly including an anode and a cathode and an electrolyte interposed between said anode and said cathode,

wherein a reactant gas supply passage, a coolant supply passage, a reactant gas discharge passage, and a coolant discharge passage extend through said fuel cell in a stacking direction of said fuel cell;

said separator at least includes first and second metal plates stacked together, and a coolant flow field is formed between said first and second metal plates;

said coolant flow field includes two or more inlet buffers connected to said coolant supply passage through inlet connection passages, two or more outlet buffers connected to said coolant discharge passage through outlet connection passages, and flow grooves extending in a separator surface direction and connected between said two or more inlet buffers and said two or more outlet buffers;

at least the number of grooves in a first inlet connection passage connecting said first inlet buffer to said coolant supply passage and the number of grooves in a

second inlet connection passage connecting said second inlet buffer to said coolant supply passage are different; and

at least the number of grooves in a first outlet connection passage connecting said first outlet buffer to said coolant discharge passage and the number of grooves in a second outlet connection passage connecting said second outlet buffer to said coolant discharge passage are different.

[Claim 2]

A fuel cell according to claim 1, wherein, a fuel gas flow field including a curved flow passage is formed on one surface of said first metal plate for supplying a fuel gas along said anode, and an oxygen-containing gas flow field including a curved flow passage is formed on one surface of said second metal plate for supplying an oxygen-containing gas along said cathode; and

a first inlet buffer connected to said coolant supply passage and a second outlet buffer connected to said coolant discharge passage are formed on the other surface of said first metal plate; and

a second inlet buffer connected to said coolant supply passage and a first outlet buffer connected to said coolant discharge passage are formed on the other surface of said second metal plate at positions different from positions of said first inlet buffer and said second outlet buffer.

[DETAILED EXPLANATION OF THE INVENTION]

[0001]

[TECHNICAL FIELD TO WHICH THE INVENTION PERTAINS]

The present invention relates to a fuel cell formed by alternatively stacking an electrolyte electrode assembly and separators. The electrolyte electrode assembly includes an anode, a cathode, and an electrolyte interposed between the anode and the cathode.

[0002]

[PRIOR ART]

For example, a solid polymer fuel cell employs a polymer ion exchange membrane as a solid polymer electrolyte membrane. The solid polymer electrolyte membrane (cation exchange membrane) is interposed between an anode and a cathode to form a membrane electrode assembly. Each of the anode and the cathode is made of electrode catalyst and porous carbon. The membrane electrode assembly (electrolyte electrode assembly) is sandwiched between separators (bipolar plates) to form the fuel cell. In use, generally, a predetermined number of the fuel cells are stacked together to form a fuel cell stack.

[0003]

In the fuel cell, a fuel gas (reactant gas) such as a gas chiefly containing hydrogen (hereinafter also referred to as the hydrogen-containing gas) is supplied to the anode. The catalyst of the anode induces a chemical reaction of the fuel gas to split the hydrogen molecule into hydrogen ions and electrons. The hydrogen ions move toward the cathode through the electrolyte, and the electrons flow through an

external circuit to the cathode, creating a DC electrical energy. An oxidizing gas (reactant gas) such as a gas chiefly containing oxygen (hereinafter also referred to as the oxygen-containing gas) is supplied to the cathode. At the cathode, the hydrogen ions from the anode combine with the electrons and oxygen to produce water.

[0004]

In the fuel cell, a fuel gas flow field (reactant gas flow field) is formed on a surface of the separator for supplying the fuel gas to the anode. An oxygen-containing gas flow field (reactant gas flow field) is formed on a surface of the separator for supplying the oxygen-containing gas to the cathode. Further, a coolant flow field is provided between the separators such that a coolant flows along the surfaces of the separators.

[0005]

Normally, the separators of this type are formed of carbon material. However, it has been found that it is not possible to produce a thin separator using the carbon material due to factors such as the strength. Therefore, recently, attempts to reduce the overall size and weight of the fuel cell using a separator formed of a thin metal plate (hereinafter also referred as the metal separator) have been made. In comparison with the carbon separator, the metal separator has the higher strength, and it is possible to produce a thin metal separator easily. The desired reactant flow field can be formed on the metal separator under

pressure to achieve the reduction in thickness of the metal separator.

[0006]

For example, a fuel cell 1 shown in FIG. 13 includes a membrane electrode assembly 5 and a pair of metal separators 6a, 6b sandwiching the membrane electrode assembly 5. The membrane electrode assembly 5 includes an anode 2, a cathode 3, and an electrolyte membrane 4 interposed between the anode 2 and the cathode 3.

[0007]

The metal separator 6a has a fuel gas flow field 7a for supplying a fuel gas such as a hydrogen-containing gas on its surface facing the anode 2. The metal separator 6b has an oxygen-containing gas flow field 7b for supplying an oxygen-containing gas such as the air on its surface facing the cathode 3. The metal separators 6a, 6b have planar regions 8a, 8b in contact with the anode 2 and the cathode 3. Further, coolant flow fields 9a, 9b as passages of a coolant is formed on back surfaces (surfaces opposite to the contact surfaces) of the planar regions 8a, 8b.

[0008]

However, in the metal separators 6a, 6b, the shapes of the coolant flow fields 9a, 9b are determined inevitably based on the shapes of the fuel gas flow field 7a and the oxygen-containing gas flow field 7b. In particular, in an attempt to achieve the long grooves, assuming that the fuel gas flow field 7a and the oxygen-containing gas flow field

7b comprise serpentine flow grooves, the shapes of the coolant flow fields 9a, 9b are significantly constrained. Therefore, it is not possible to supply the coolant along the entire surfaces of the metal separators 6a, 6b. Thus, because the coolant is caused to be partly stagnated in the coolant flow fields of the metal separators 6a, 6b, it is difficult to uniformly cool the electrode surfaces, and achieve the stable power generation performance.

[0009]

In view of the above, for example, Patent document 1 discloses a separator of a fuel cell. The separator is a metal separator, and includes two corrugated metal plates having gas flow fields, and a corrugated metal intermediate plate sandwiched between the two metal plates. The metal intermediate plate has coolant water flow fields on both surfaces.

[0010]

[Patent document 1]

Japanese Laid-Open Patent Publication No. 2002-75395 (Paragraphs [0009] to [0012], FIG. 3)

[0011]

[TASK TO BE SOLVED BY THE INVENTION]

However, according to the disclosure of Patent document 1, the metal separator has three metal plates including the two metal plates having gas flow fields, and the one intermediate metal plate having the coolant flow fields on its both surfaces. Therefore, in particular, when a large

number of metal separators are stacked to form the fuel cell stack, the number of components of the fuel cell stack is large, and the dimension in the stacking direction of the metal separators is large. Thus, the overall size of the fuel cell stack is large.

[0012]

The present invention solves this type of problem, and an object of the present invention is to provide a fuel cell having a simple and small structure in which a coolant flows in a surface of a separator uniformly, and the desired power generation performance is achieved.

[0013]

[SOLUTION FOR THE TASK]

In a fuel cell of the present invention recited in claim 1, an electrolyte electrode assembly and separators are stacked alternately, and the separator at least includes first and second metal plates stacked together, and a coolant flow field is formed between said first and second metal plates. The coolant flow field includes two or more inlet buffers connected to the coolant supply passage through inlet connection passages, two or more outlet buffers connected to the coolant discharge passage through outlet connection passages, and flow grooves extending in a separator surface direction and connected between the two or more inlet buffers and the two or more outlet buffers.

[0014]

The coolant between the first and second metal plates flows separately from the coolant supply passage into the two or more inlet buffers, flows through the flow grooves into the two or more outlet buffers, and is discharged into the coolant discharge passage.

[0015]

Further, at least the number of grooves in a first inlet connection passage connecting the first inlet buffer to the coolant supply passage and the number of grooves in a second inlet connection passage connecting the second inlet buffer to the coolant supply passage are different; and at least the number of grooves in a first outlet connection passage connecting said first outlet buffer to said coolant discharge passage and the number of grooves in a second outlet connection passage connecting said second outlet buffer to said coolant discharge passage are different.

[0016]

Therefore, the cancellation of pressures in the coolant flow field is prevented. Thus, the desired flow rate and the desired flow condition of the coolant in the coolant flow field are achieved. Accordingly, the coolant flows in the separator surface uniformly, and cools the entire electrode surface uniformly. Thus, the stable power generation performance of the fuel cell can be achieved.

[0017]

Further, in a fuel cell of the present invention recited in claim 2, a fuel gas flow field including a curved

the present invention. FIG. 2 is a cross sectional view showing part of the fuel cell 10.

[0021]

The fuel cell 10 is formed by stacking a membrane electrode assembly (electrolyte electrode assembly) 12 and separators 13 alternately. Each of the separators 13 includes first and second metal plates 14, 16 which are stacked together.

[0022]

As shown in FIG. 1, at one end of the membrane electrode assemblies 12 and the separators 13 in a direction indicated by an arrow B, an oxygen-containing gas supply passage 20a for supplying an oxidizing gas (reactant gas) such as an oxygen-containing gas, a coolant supply passage 22a for supplying a coolant, and a fuel gas discharge passage 24b for discharging a fuel gas (reactant gas) such as a hydrogen-containing gas are arranged vertically in a direction indicated by an arrow C. The oxygen-containing gas supply passage 20a, the coolant supply passage 22a, and the fuel gas discharge passage 24b extend through the fuel cell 10 in the stacking direction indicated by an arrow A.

[0023]

At the other end of the membrane electrode assemblies 12 and the separators 13 in the direction indicated by the arrow B, a fuel gas supply passage 24a for supplying the fuel gas, a coolant discharge passage 22b for discharging the coolant, and an oxygen-containing gas discharge passage

20b for discharging the oxygen-containing gas are arranged vertically in the direction indicated by the arrow C. The fuel gas supply passage 24a, the coolant discharge passage 22b, and the oxygen-containing gas discharge passage 20b extend through the fuel cell 10 in the direction indicated by the arrow A.

[0024]

The membrane electrode assembly 12 comprises an anode 28, a cathode 30, and a solid polymer electrolyte membrane 26 interposed between the anode 28 and the cathode 30. The solid polymer electrolyte membrane 26 is formed by impregnating a thin membrane of perfluorosulfonic acid with water, for example.

[0025]

Each of the anode 28 and the cathode 30 has a gas diffusion layer such as a carbon paper, and an electrode catalyst layer of platinum alloy supported on carbon particles. The carbon particles are deposited uniformly on the surface of the gas diffusion layer. The electrode catalyst layer of the anode 28 and the electrode catalyst layer of the cathode 30 are fixed to both surfaces of the solid polymer electrolyte membrane 26, respectively, such that the electrode catalyst layers face each other with the solid polymer electrolyte membrane 26 interposed therebetween.

[0026]

As shown in FIGS. 1 and 3, the first metal plate 14 has

on the surface 14b. Further, the second outlet buffer 50 connected to the coolant discharge passage 22b through the two connection grooves is provided on the surface 14b.

[0037]

Grooves 60a, 62a, 64a, and 66a connected to the first inlet buffer 44 extend discontinuously in the direction indicated by the arrow B for a predetermined distance. The grooves 60a, 62a, 64a, and 66a are formed where the turn region T2 of the oxygen-containing gas flow grooves 38a through 38c and the outlet buffer 36 is not formed. Grooves 68a, 70a, 72a, and 74a connected to the second outlet buffer 50 extend in the direction indicated by the arrow B. The grooves 68a, 70a, 72a, and 74a are formed where the turn region T1 of the oxygen-containing gas flow grooves 38a through 38c and the inlet buffer 34 is not formed.

[0038]

The grooves 60a through 78a are part of the straight flow grooves 60 through 78, respectively. Grooves 80a through 90a as part of the straight flow grooves 80 through 90 extend in the direction indicated by the arrow C for a predetermined distance where the serpentine oxygen-containing gas flow grooves 38a through 38c are not formed.

[0039]

As shown in FIG. 6, part of the coolant flow field 42 is formed on the surface 16a of the second metal plate 16 where the fuel gas flow field 96 as described later is not formed. Specifically, the second inlet buffer 46 connected

to the coolant supply passage 22a, and the first outlet buffer 48 forming the coolant discharge passage 22b are provided.

[0040]

Grooves 68b through 74b of the straight flow grooves 68 through 74 connected to the second inlet buffer 46 extend discontinuously in the direction indicated by the arrow B for a predetermined distance. Grooves 60b through 66b of the straight flow grooves 60 through 66 connected to the first outlet buffer 48 extend in a predetermined pattern. On the surface 16a, grooves 80b through 90b of the straight flow grooves 80 through 90 extend in the direction indicated by the arrow C.

[0041]

In the coolant flow field 42, at part of the straight flow grooves 60 through 78 extending in the direction indicated by the arrow B, the grooves 60a through 78a and the grooves 60b through 78b face each other to form a main flow field. The sectional area of the main flow field in the coolant flow field 42 is twice as large as the sectional area of the other part of the coolant flow field 42 (see FIGS. 4 and 7). The straight flow grooves 80 through 90 are partially defined by grooves on both surfaces 14b, 16a of the first and second metal plate 14, 16, partially defined on one surface 14b of the first metal plate 14, and partially defined on one surface 16a of the second metal plate 16 (see FIG. 8). A line seal 40a is formed between

the surface 14a of the first metal plate 14 and the surface 16a of the second metal plate 16.

[0042]

As shown in FIG. 9, the second metal plate 16 has the fuel gas flow field 96 on its surface 16b facing the membrane electrode assembly 12. The fuel gas flow field 96 includes an inlet buffer 98 provided near the fuel gas supply passage 24a, and an outlet buffer 100 provided near the fuel gas discharge passage 24b.

[0043]

A plurality of bosses 98a, 100a are formed in the inlet buffer 98 and the outlet buffer 100, respectively. For example, the inlet buffer 98 and the outlet buffer 100 are connected by three fuel gas flow grooves 102a, 102b, 102c. The fuel gas flow grooves 102a through 102c extend in a serpentine pattern for allowing the fuel gas to flow back and forth in the direction indicated by the arrow B, and flows in the direction indicated by the arrow C. The fuel gas flow grooves 102a through 102c are substantially serpentine flow grooves having two turn regions T3, T4, and three straight regions, for example. On the surface 16b, a line seal 40b is provided around the fuel gas flow field 96.

[0044]

Next, operation of the fuel cell 10 according to the present embodiment will be described.

[0045]

As shown in FIG. 1, an oxidizing gas such as an oxygen-

containing gas is supplied to the oxygen-containing gas supply passage 20a, a fuel gas such as a hydrogen-containing gas is supplied to the fuel gas supply passage 24a, and a coolant such as pure water, an ethylene glycol or an oil is supplied to the coolant supply passage 22a.

[0046]

The oxygen-containing gas flows from the oxygen-containing gas supply passage 20a into the oxygen-containing gas flow field 32 of the first metal plate 14. As shown in FIG. 3, the oxygen-containing gas flows through the inlet buffer 34, and is distributed into the oxygen-containing gas flow grooves 38a through 38c. The oxygen-containing gas flows through the oxygen-containing gas flow grooves 38a through 38c in a serpentine pattern along the cathode 30 of the membrane electrode assembly 12.

[0047]

The fuel gas flows from the fuel gas supply passage 24a into the fuel gas flow field 96 of the second metal plate 16. As shown in FIG. 9, the fuel gas flows through the inlet buffer 98, and is distributed into the fuel gas flow grooves 102a through 102c. The fuel gas flows through the fuel gas flow grooves 102a through 102c in a serpentine pattern along the anode 28 of the membrane electrode assembly 12.

[0048]

In the membrane electrode assembly 12, the oxygen-containing gas supplied to the cathode 30, and the fuel gas

supplied to the anode 28 are consumed in the electrochemical reactions at catalyst layers of the cathode 30 and the anode 28 for generating electricity.

[0049]

After the oxygen-containing gas is consumed at the cathode 30, the oxygen-containing gas flows into the oxygen-containing gas discharge passage 20b through the outlet buffer 36. Likewise, after the fuel gas is consumed at the anode 28, the fuel gas flows into the fuel gas discharge passage 24b through the outlet buffer 100.

[0050]

The coolant supplied to the coolant supply passages 22a flows into the coolant flow field 42 between the first and second metal plates 14, 16. As shown in FIG. 4, the coolant from the coolant supply passage 22a flows through the first and second connecting inlet flow grooves 52, 54 in the direction indicated by the arrow C, and flows into the first and second inlet buffers 44, 46.

[0051]

The coolant is distributed from the first and second inlet buffers 44, 46 into the straight flow grooves 60 through 66, and 68 through 74, and flows horizontally in the direction indicated by the arrow B. The coolant also flows through the straight flow grooves 80 through 90, 76, and 78. Thus, the coolant is supplied to the entire power generation surface of the membrane electrode assembly 12. Then, the coolant flows through the first and second outlet buffers

having a predetermined shape are formed where the serpentine oxygen-containing gas flow grooves 38a through 38c are not formed (see FIGS. 3 and 5).

[0054]

Further, part of the coolant flow field 42 is formed on the surface 16a of the second metal plate 16 where the fuel gas flow field 96 on the surface 16b is not formed. Specifically, as shown in FIG. 9, the second inlet buffer 46 is formed at a position above the coolant supply passage 22a where the outlet buffer 100 is not formed. Further, the first outlet buffer 48 is formed at a position below the coolant discharge passage 22b where the inlet buffer 98 is not formed. Further, the grooves 60b through 90b each having a predetermined shape are formed where the serpentine oxygen fuel gas flow grooves 102a through 102c are not formed (see FIGS. 6 and 9).

[0055]

In this manner, even though the shape of the coolant flow field 42 on the first metal plate 14 is constrained by the oxygen-containing gas flow field 32, and the shape of the flow field on the second metal plate 16 is constrained by the fuel gas flow field 96, the coolant flow field 42 on the first metal plate 14 and the coolant flow field 42 on the second metal plate 16 compensate with each other. Therefore, with the simple structure, the coolant flow field 42 having the desired shape is reliably formed in the separator 13.

[0056]

In the present embodiment, the first and second connecting inlet flow grooves 52, 54 connecting the coolant supply passage 22a and the first and second inlet buffers 44, 46 are provided. For example, the first connecting inlet flow groove 52 comprises two flow grooves, and the second connecting inlet flow groove 54 includes six flow grooves.

[0057]

Likewise, the first and second connecting outlet flow grooves 56, 58 connecting the coolant discharge passage 22b and the first and second outlet buffers 48, 50 are provided. For example, the first connecting outlet flow groove 56 comprises six flow grooves, and the second connecting outlet flow groove 58 comprises two flow grooves.

[0058]

Therefore, as shown in FIG. 10, assuming that a position near the first inlet buffer 44 is defined as the position P1, and a position near the second inlet buffer 46 is defined as the position P2, the flow resistance from the coolant supply passage 22a to the position P1 is larger than the flow resistance from the coolant supply passage 22a to the position P2. Therefore, the pressure of the coolant applied to the position P2 is larger than the pressure of the coolant applied to the position P1. Thus, it is possible to prevent stagnation of the coolant, enabling the flow of the coolant to be smoothly and uniformly adjusted in

the coolant flow field 42.

[0059]

The flow rate and temperature distribution in the coolant flow field 42 were confirmed in a comparative example and the present embodiment. In the comparative example, the number of flow grooves of the first connecting inlet flow groove 52 and the number of flow grooves of the second connecting inlet flow groove 54 are the same, and the number of the flow grooves of the first connecting outlet flow groove 56 and the number of flow grooves of the second connecting inlet flow groove 54 are the same. The confirmation was made around positions Pa, Pb, Pc, and Pd along a central line T connecting the coolant supply passage 22a and the coolant discharge passage 22b. As shown in FIG. 10, the positions Pa, Pd are end positions of the coolant flow field 42. The distance (H) between the position Pb and the position Pa and the distance (H) between the position Pc and the position Pd were set to 1/2 of the flow field width (2H) of the coolant flow field 42.

[0060]

As a result, in the comparative example, since the pressure at the position P1 and the pressure at the position P2 were substantially the same, as shown in FIG. 11, near the position Pa, the flow rate of the coolant supplied from the first inlet buffer 44 was canceled with the pressure of the coolant supplied from the second inlet buffer 46. Therefore, the flow rate of the coolant was small near the

positions Pa to Pd on the central line T. In contrast, in the present embodiment, since the pressure at the position P2 is higher than the pressure at the position P1, the pressure difference efficiently suppresses reduction in the flow rate along the vicinities of the positions Pa to Pd on the central line T.

[0061]

Further, as shown in FIG. 12, in the comparative example, the temperature was high near the positions Pa, Pb and the positions Pc, Pd since the coolant did not flow smoothly. In contrast, in the present embodiment, the coolant flowed smoothly by the pressure difference. Therefore, in the temperature distribution of the present embodiment, the temperature increased from the coolant supply passage 22a to the coolant discharge passage 22b at a constant inclination angle.

[0062]

Thus, in the present embodiment, the coolant flows smoothly and reliably in the coolant flow field 42. It is possible to uniformly and reliably cool the entire power generation surface of the membrane electrode assembly 12.

[0063]

In the present embodiment, the number of the flow grooves of the first connecting inlet flow groove 52 is smaller than the number of the flow grooves of the second connecting inlet flow groove 54. Conversely, the number of the flow grooves of the first connecting inlet flow groove

52 may be larger the number of the flow grooves of the second connecting inlet flow groove 54. Likewise, the number of the flow grooves of the second connecting outlet flow groove 58 may be larger the number of the flow grooves of the first connecting outlet flow groove 56. In the present embodiment, the numbers of the flow grooves are two and six. However, the present invention is not limited in this respect. As long as the numbers of the flow grooves are different, various combinations of numbers may be adopted.

[0064]

Although the above explanation has been made using the first and second inlet buffers 44, 46 and the first and second outlet buffers 48, 50, the present invention is not limited thereto. For example, three or more inlet buffers connected to the coolant supply passage 22a, and three or more outlet buffers connected to the coolant discharge passage 22b can be provided.

[0065]

[EFFECT OF THE INVENTION]

In the fuel cell according to the present invention, the coolant supplied from the coolant supply passage through inlet connecting flow grooves to two or more inlet buffers flows along the separator surface in the flow grooves, and is discharged to the coolant discharge passage from two or more outlet buffers through the outlet connecting flow grooves.

[0066]

Further, in the present invention, the numbers of the flow grooves of the respective inlet connecting flow grooves are different, and the numbers of the flow grooves of the respective outlet connecting flow grooves are different. Thus, the desired flow rate and the desired flow condition of the coolant in the coolant flow field are achieved. Accordingly, the coolant flows in the separator surface uniformly, and cools the entire electrode surface uniformly. Thus, the stable power generation performance can be achieved.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[FIG. 1]

FIG. 1 is an exploded perspective view showing main components of a fuel cell according to an embodiment of the present invention.

[FIG. 2]

FIG. 2 is a cross sectional view showing part of the fuel cell.

[FIG. 3]

FIG. 3 is a front view showing one surface of a first metal plate.

[FIG. 4]

FIG. 4 is a perspective view showing a coolant flow field formed in a separator.

[FIG. 5]

FIG. 5 is a front view showing the other surface of the

first metal plate.

[FIG. 6]

FIG. 6 is a front view showing a second separator.

[FIG. 7]

FIG. 7 is a cross sectional view taken along a line VII-VII in FIG. 4.

[FIG. 8]

FIG. 8 is a cross sectional view taken along a line VIII-VIII in FIG. 4.

[FIG. 9]

FIG. 9 is a front view showing the other surface of the second metal plate.

[FIG. 10]

FIG. 10 is an exploded perspective view showing main components of a fuel cell according to a second embodiment of the present invention.

[FIG. 11]

FIG. 11 is a view showing the relationship between the measured positions and the flow rate in the sixth embodiment and a comparative example.

[FIG. 12]

FIG. 12 is a view showing the relationship between the measured positions and the temperature in the sixth embodiment and the comparative example.

[FIG. 13]

FIG. 13 is a cross sectional view showing part of a conventional fuel cell.

[DESCRIPTION OF REFERENCE NUMERALS]

10: fuel cell, 12: membrane electrode assembly,

13: separator,

14, 16: metal plate,

20a: oxygen-containing gas supply passage,

20b: oxygen-containing gas discharge passage,

22a: coolant supply passage, 22b: coolant discharge passage,

24a: fuel gas supply passage,

24b: fuel gas discharge passage,

26: solid polymer electrolyte membrane, 28: anode,

30: cathode, 32: oxygen-containing gas flow field,

42: coolant flow field, 34, 44, 46: inlet buffer,

36, 48, 50: outlet buffer,

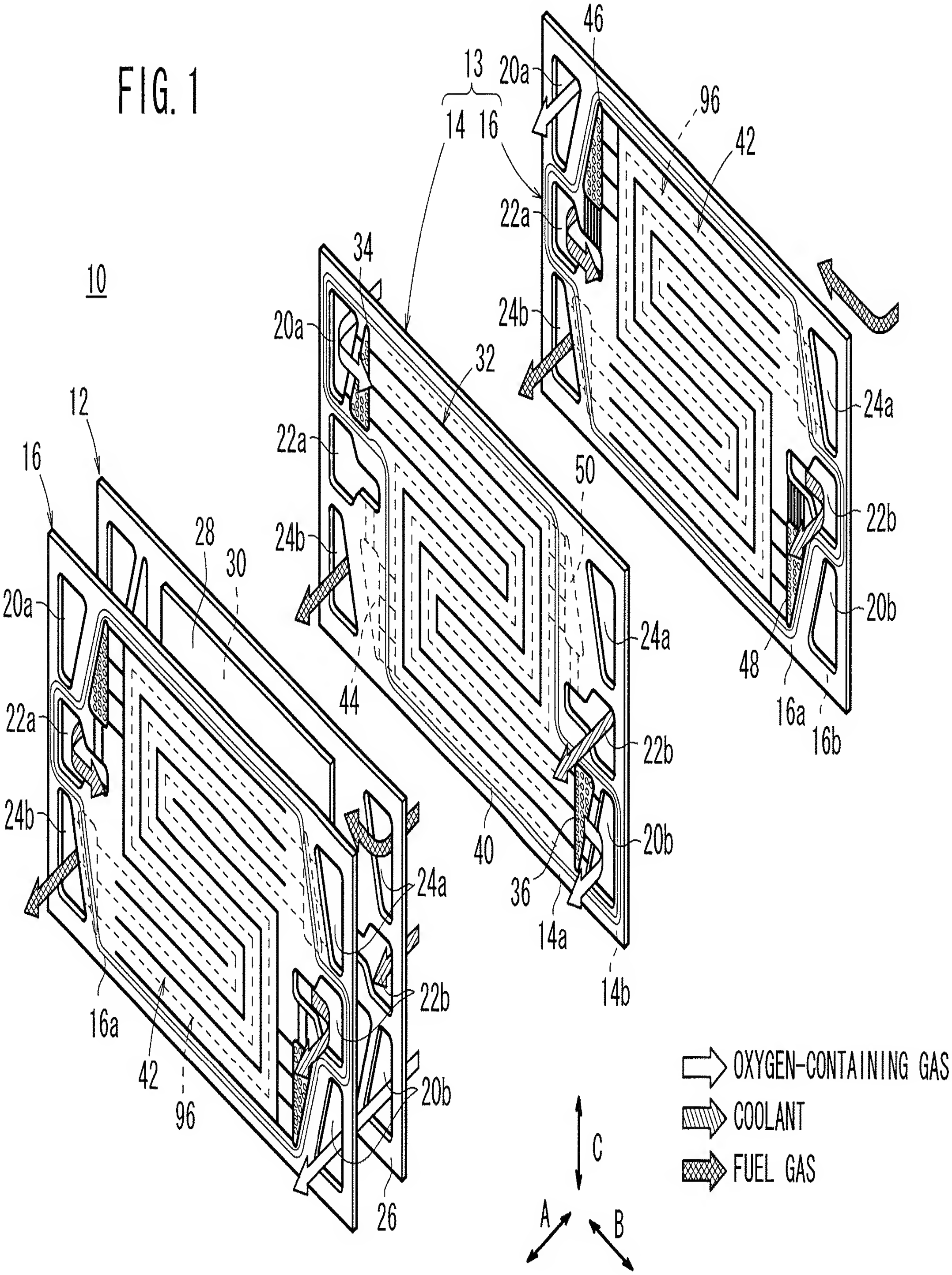
52, 54: inlet connecting flow groove,

56, 58: outlet connecting flow groove,

60 to 90: straight flow groove

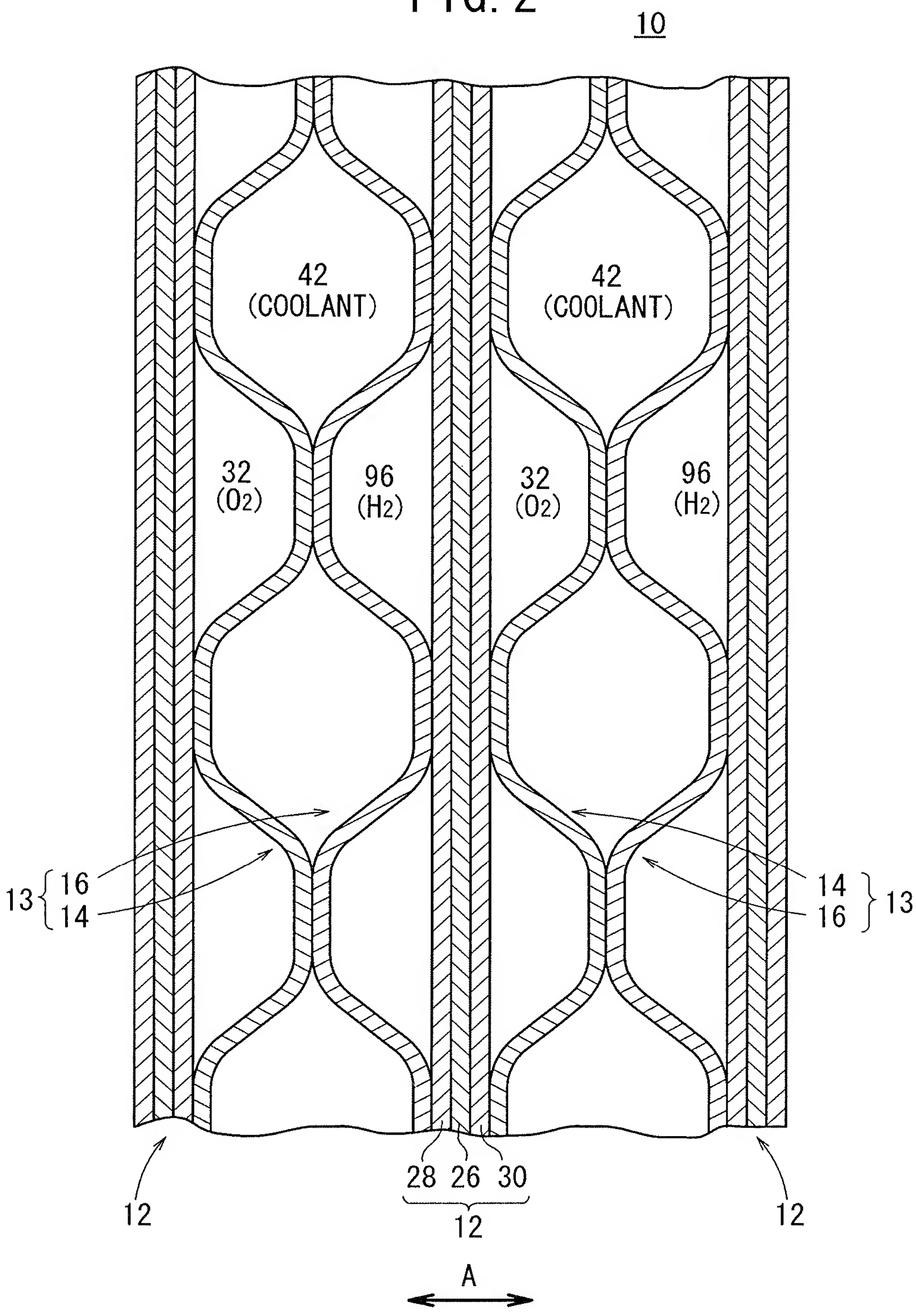
96: fuel gas flow field

FIG. 1



10
12
13
14
16
20a
22a
24b
28
30
32
34
46
96
42
24a
22b
20b
50
44
40
36
14a
14b
48
16a
16b
26
OXYGEN-CONTAINING GAS
COOLANT
FUEL GAS
A
B
C

FIG. 2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(COOLANT)
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(O_2)
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16
14
14
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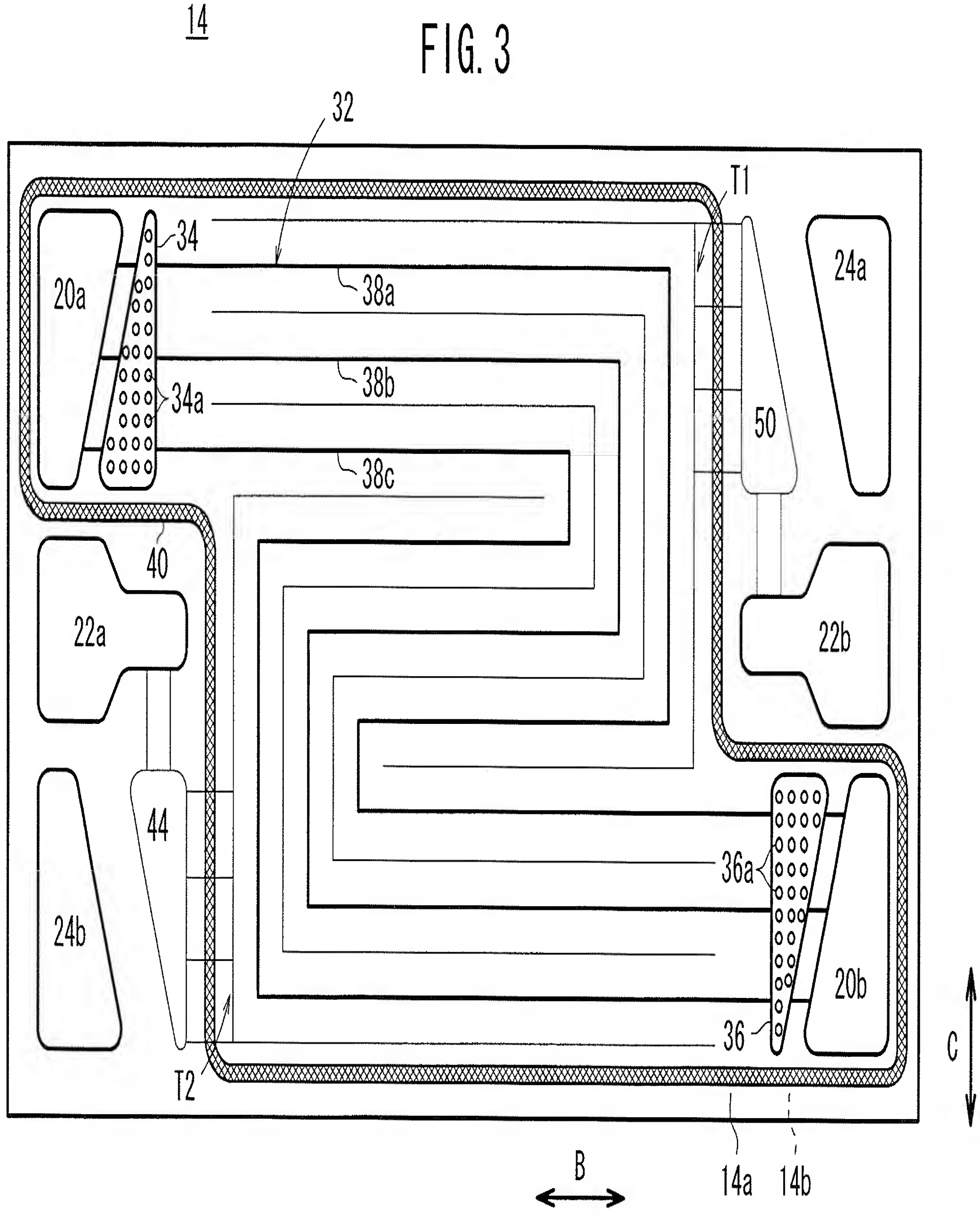
13
12
28
26
30
12
12
A

FIG. 3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32
T1
34
20a
38a
24a
38b
34a
50
38c
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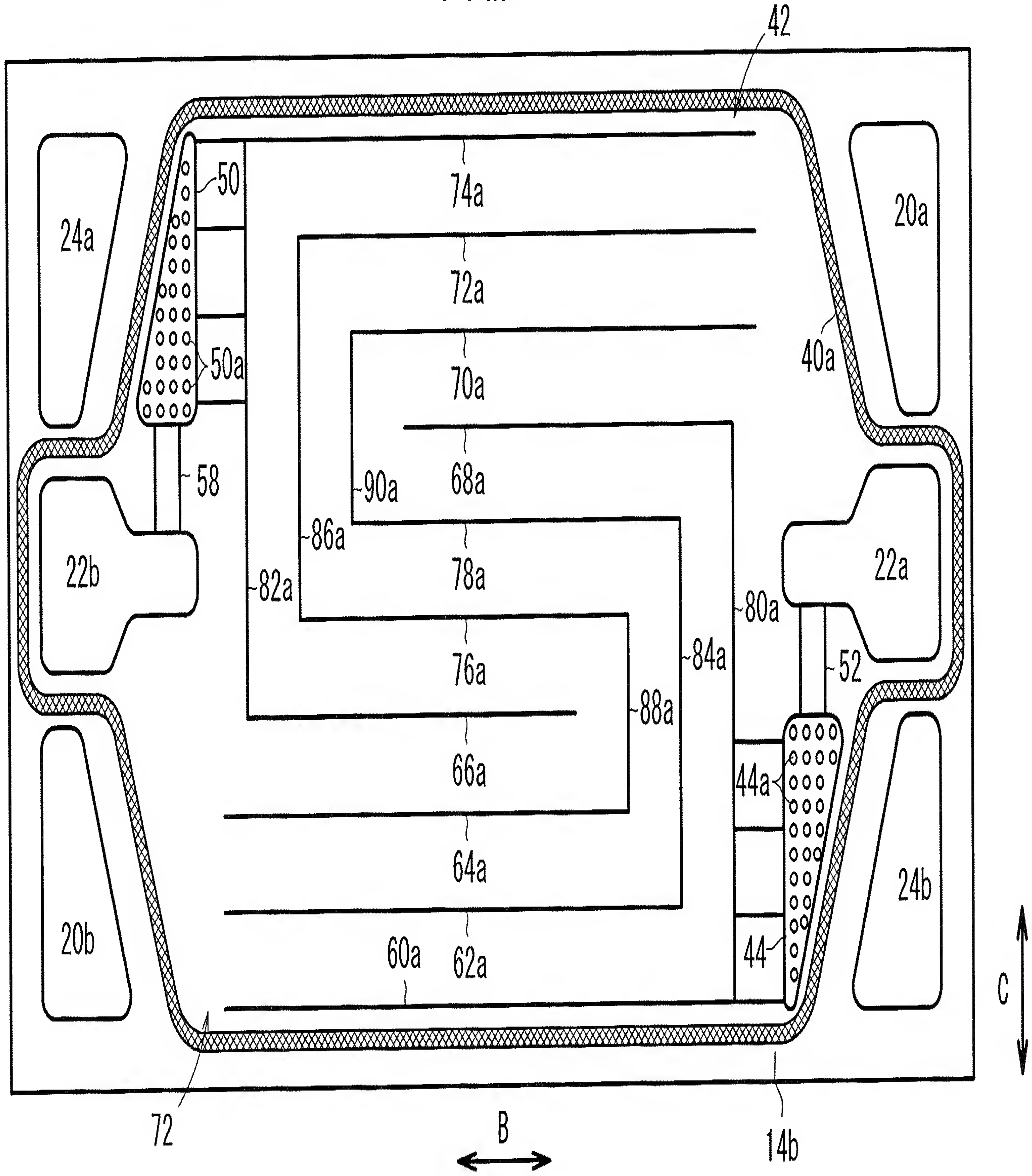
22a
22b
44
36a
24b
20b
36
C
T2
B
14a
14b

FIG. 5



14
42
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72a
70a
68a
78a
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66a
64a
62a
60a
50
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22b
24a
20b
20a
40a
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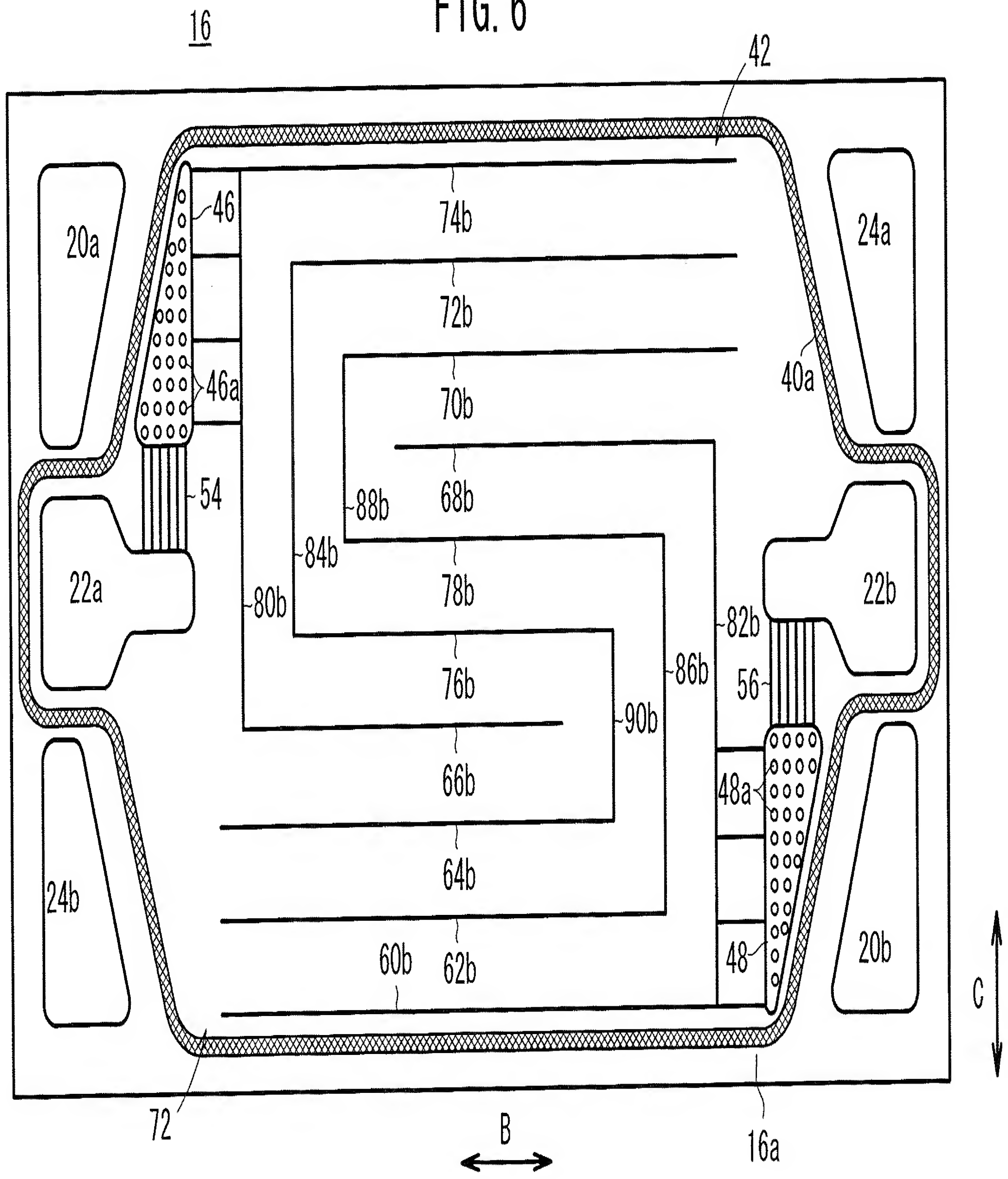
14b

FIG. 6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42
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72b
46a
70b
40a
54
88b
68b
84b
22a
80b
78b
82b
22b
86b
76b
56
90b
66b
48a
24b
64b
60b
62b
48
20b
C
72
B
16a

FIG. 7

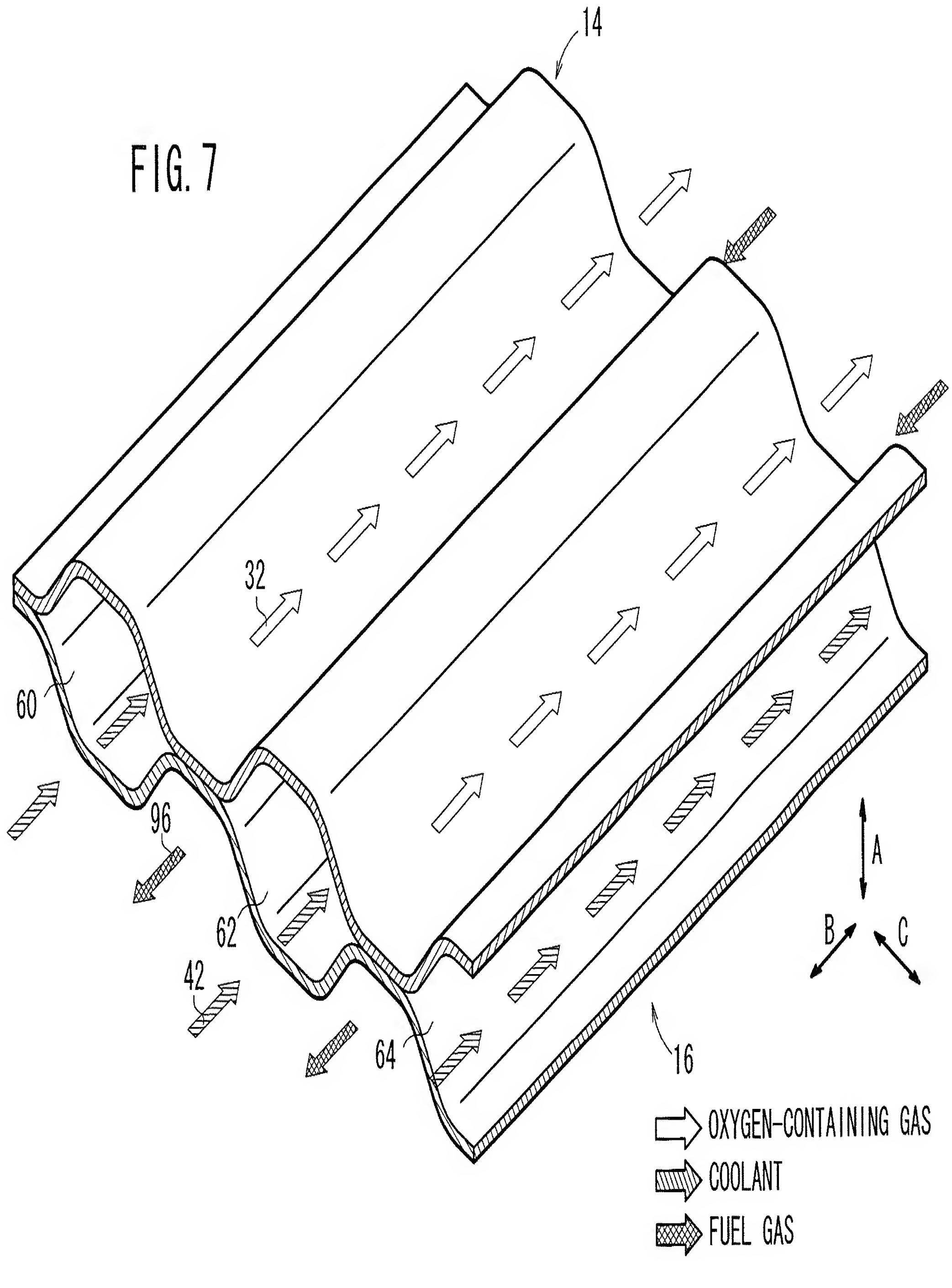
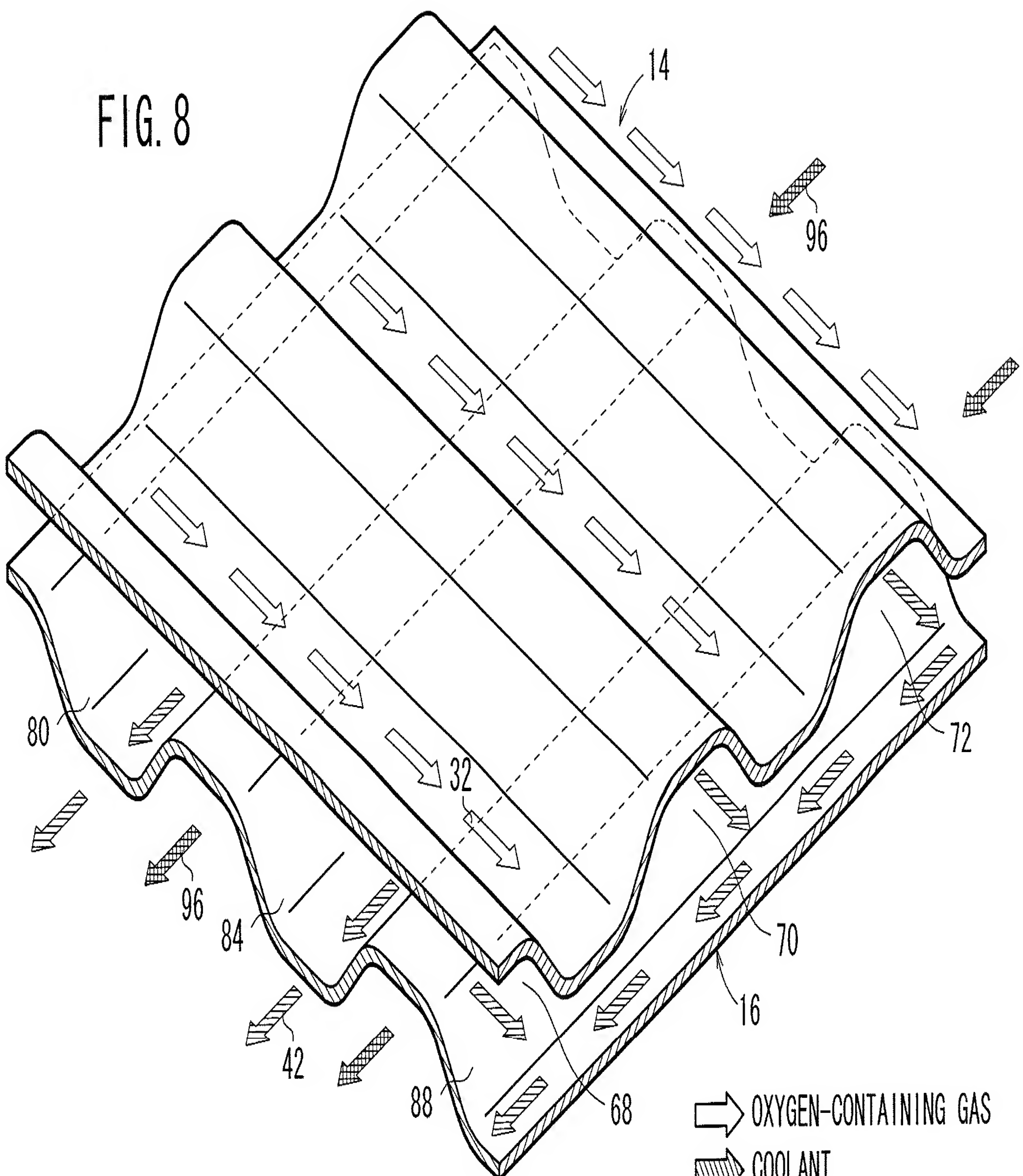

14
32
60
96
62
42
64
16
A
B
C
OXYGEN-CONTAINING GAS
COOLANT
FUEL GAS

FIG. 8



14
96
80
32
72
70
96
84
16
42
88
68
OXYGEN-CONTAINING GAS
COOLANT
FUEL GAS

FIG. 9

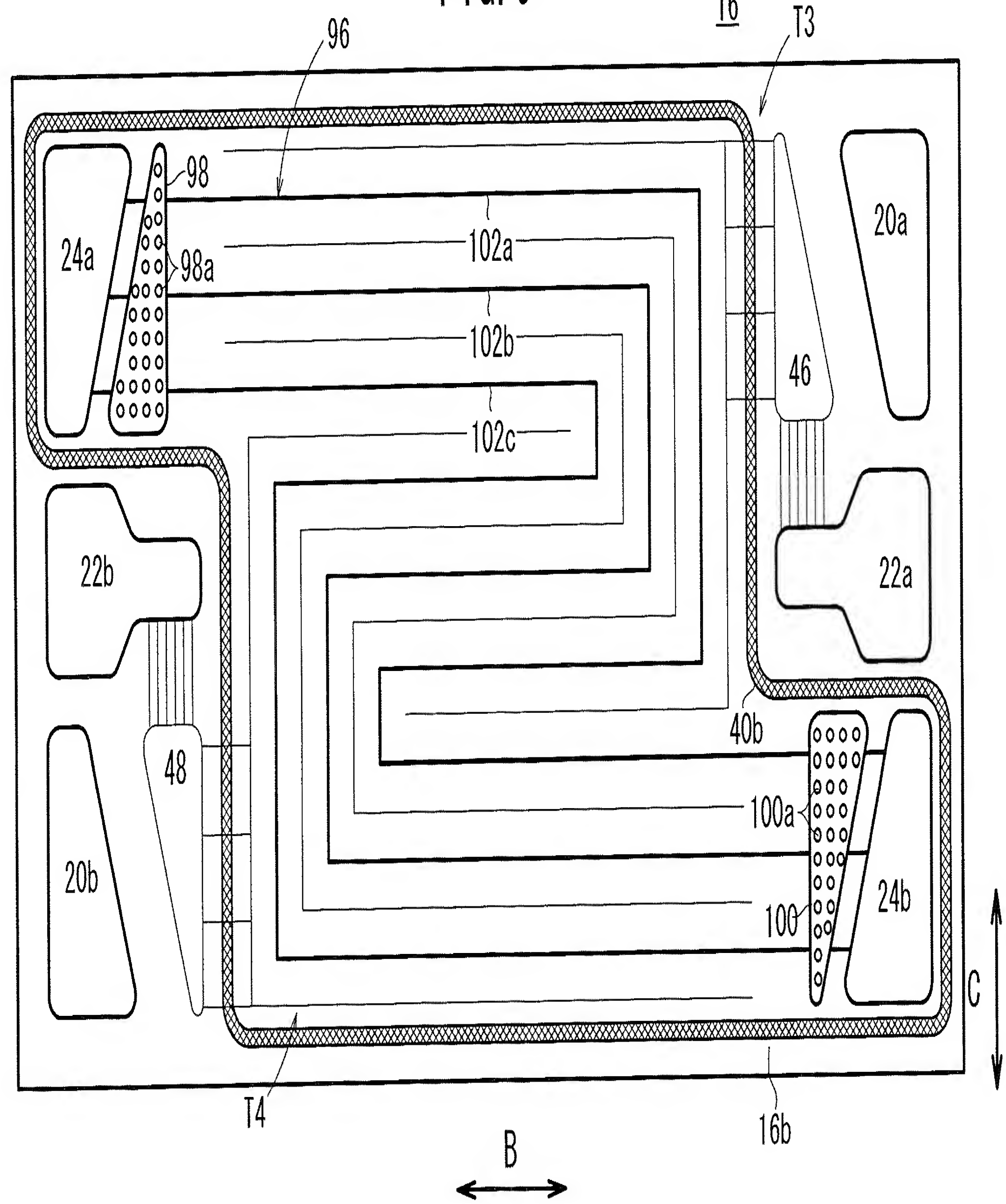

16
T3
96
98
24a
98a
102a
102b
102c
20a
46
22b
22a
40b
48
100a
20b
24b
100
C
T4
16b
B

FIG. 10

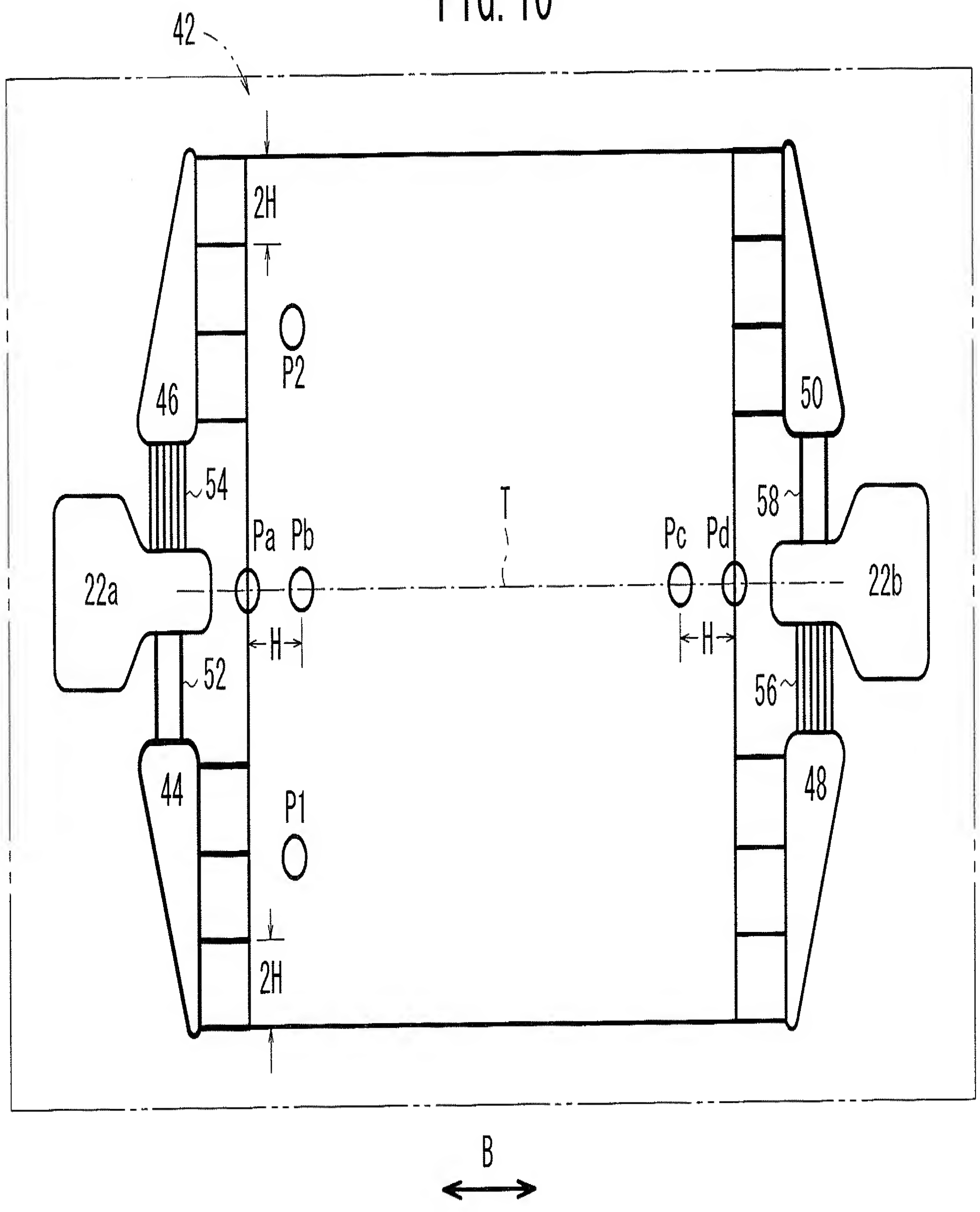


FIG. 11

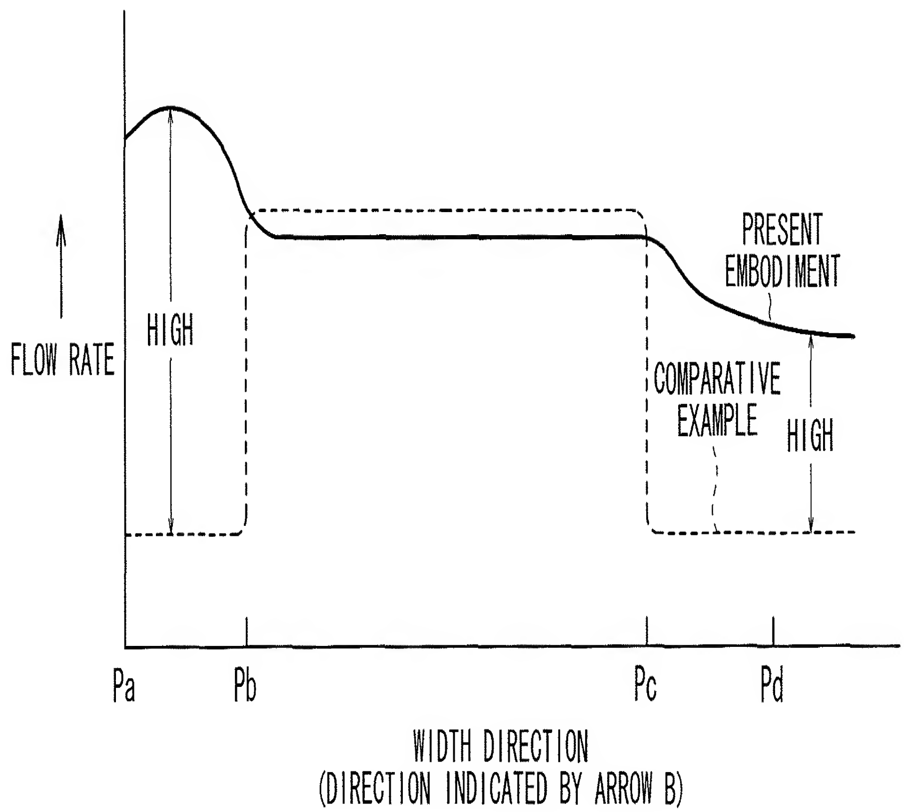
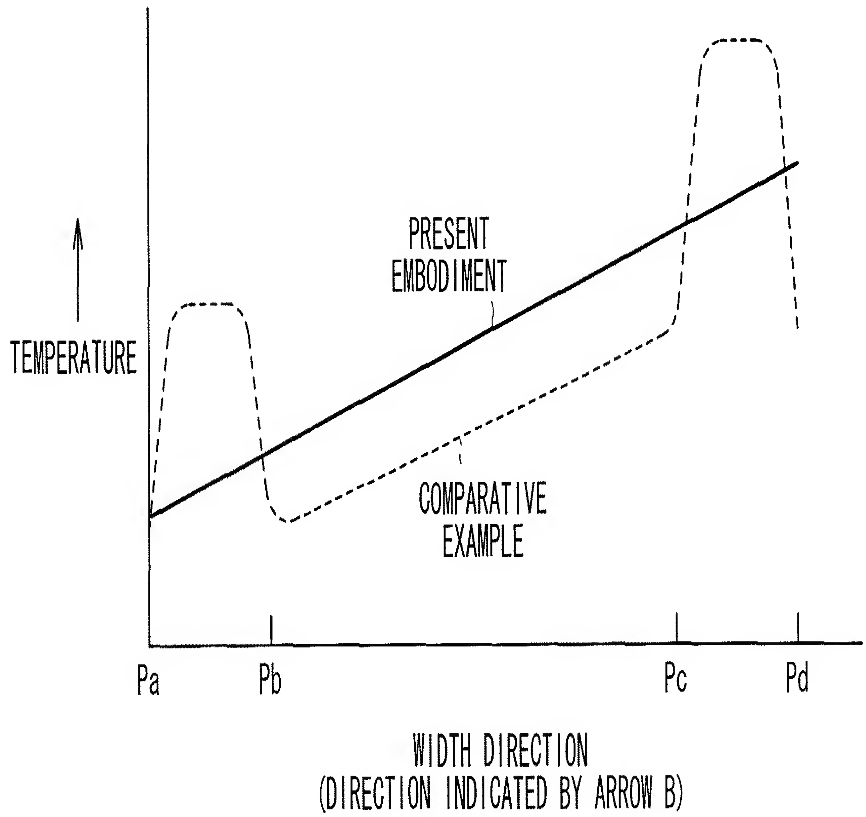

FLOW RATE
HIGH
PRESENT EMBODIMENT
COMPARATIVE EXAMPLE
HIGH
Pa
Pb
Pc
Pd
WIDTH DIRECTION
(DIRECTION INDICATED BY ARROW B)

FIG. 12



TEMPERATURE
PRESENT EMBODIMENT
COMPARATIVE EXAMPLE
Pa
Pb
Pc
Pd
WIDTH DIRECTION
(DIRECTION INDICATED BY ARROW B)

[DOCUMENT NAME] Abstract

[ABSTRACT]

[TASK] To secure a suitable power generation performance with a simple structure by allowing a coolant to flow uniformly throughout a separator surface.

[SOLUTION] A coolant flow field 42 is formed between first and second metal plates 14, 16 forming a separator 13. A coolant flow field 42 includes first and second inlet buffers 44, 46 connected to a coolant supply passage 22a via first and second inlet connecting flow grooves 52, 54, first and second outlet buffers 48, 50 connected to a coolant discharge passage 22b via first and second outlet connecting flow grooves 52, 54. The numbers of the first and second inlet connecting flow grooves 52, 54 are set to be different from each other, and the numbers of the first and second outlet connecting flow grooves 56, 58 are set to be different from each other.

[SELECTED FIGURE] FIG. 4